

1998 Materials Research Society Fall Meeting

Symposium Q

High Temperature Superconductors- Materials Challenges

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Final Technical Report

Chairs: Joseph Budnick

Siu-Wai Chan

Wei-Kan Chu

John Kirtley

Keichi Tanabe

Symposium Q on High Temperature Superconductors—Materials Challenges, covered a variety of HTS Materials issues. The symposium lasted three and half days with two evening poster sessions. A total of 135 papers were delivered, and 80 of those were oral presentations. The attendance was usually around 150 while a few keynote speakers drew larger audiences of over 200. A good fraction of the participants were from Japan and Europe. Overall, the authors honored the title of the symposium. All the material-sensitive issues were discussed, and were appropriate for a MRS meeting.

New techniques were reported to fine-tuned HTS properties, particularly concerning boundaries and interfaces, and improving stability of the HTS materials in ambient and operating condition.

On the basic physics issues, pairing symmetry in a number of cuprates using tricrystals and scanning SQUID (superconducting quantum interference device) microscopy was reviewed and provided clear evidence for d-wave order parameter symmetry. Chang Tsuei of IBM also described the materials aspects behind the tricrystal experiments. It is perhaps surprising that these experiments work so beautifully given faceting occurs in grain boundaries of the cuprate superconductors. The aspect of how boundary facets affecting critical current was taken up by a preliminary report from Columbia University. Two boundaries of the same misorientation but of different

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boundary planes exhibited drastically different critical currents. These were measured by the scanning squid microscopy of Josephson vortices trapped at the boundary. It is a promising technique.

A group from Brookhaven National Laboratory reported on the critical current density measured from a set of BSSCO bulk bicrystals with common c-axis but with different misorientation about c-axis. They find that the supercurrent densities are independent of misorientation angle with the boundary critical current same as the intragrain critical current. This is a puzzling results since one might expect a d-wave superconductor (from photoemission, tunneling and tricrystal phase sensitive measurements) to show some angular dependence of J_c in this geometry. However, the critical current densities are several orders of magnitude smaller than observed in YBCO. These are not true 4-terminal measurements. Recently the same group have published work in which they show that when pinning in the bulk of BSCCO is enhanced by introducing radiation induced tracks, the critical current of the bicrystal boundary is well below that of bulk crystals, in better agreement with results obtained from YBCO.

Miller talked about bulk bicrystals grown by using standard crystal growth techniques from two misoriented seed crystals. He claims that these bicrystals boundaries are very smooth and atomically perfect. However, a puzzle remains in that these bicrystals have critical current densities about 30 times smaller than reported for thin films bicrystals with the same misorientation angles. It is difficult to understand how better grain boundaries result in lower critical current densities. Ken Grey and co-worker at Argonne have suggested that this discrepancy could be the result of larger pinning of Josephson vortices in the (more faceted) thin films grain boundaries. This is an area that needs more study.

Dan Davidov of Hebrew University of Jerusalem reported on microwave mapping of the materials properties of superconductors using millimeter-wave near-field microscopy. This is a method for mapping out the surface resistance of a sample by measuring the reflected radiation. A resolution of 20 microns was reported. All the measurements reported were done at room temperature. This would the mapping of surface resistance in inhomogeneous films, which would be very useful when the techniques can be applied below T_c .

Bob Markiewicz reported on his slave-Boson calculations of the normal and superconducting states of the cuprates, in particular in the under-doped region, where pseudo-gap phenomena are presented. He described a point of view in which both the pseudo-gap and superconducting gap fall out of the formalism in a natural way. He described how tunneling and photoemission measurements could be understood within this model.

Flux dynamics and the status of flux pinning in HTS was reported and reviewed. The effects of twin boundaries in YBCO where the refinement of twin spacing and twin domain can lead to flux pinning were systematically demonstrated on the melt-textured samples with different amount of 211. Pinning centers of Pb-doped Bi-2212 was reviewed and sorted out by a systematic study of microstructure, critical current and anisotropy in resistivity.

Large area (20cmx20cm) YBCO films with high quality and reproducibility were reported. Both Ion beam assisted deposition (IBAD) and Rolling-Assisted Biaxially Textured Substrates (RABiTS) have made incremental progress toward large area YBCO coated conductor development. Several DOE funded wire projects and Japan' wire and cable projects were reviewed. Significant progress on both Bi-2212 and 2223 were reported. Our overall impression is that equal amount of research activities in both Bi-2212 and YBCO materials toward wire development were presented in this meeting. Two exciting activities related to Hg-HTS are worth mentioning here; one involves the development of high quality thin films using Tl-HTS as a structure precursor via Hg/Tl ion exchange annealing. The other is the development of a new way to reduce cost for HTS conductors by coating Hg-1223 thin films on Ni substrates.

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Authorizing Official: DR. Maribel R. Soto

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Joyce Keith
DTIC Point of Contact

22 Sep 99
Date



**Materials
Research
Society**

506 Keystone Drive
Warrendale, PA 15086-7573
<http://www.mrs.org/>

724-779-3003
FAX 724-779-8313

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Dr. Maribel R. Soto
Office of Naval Research
800 N Quincy St
Arlington VA 22217-5660

Dear Dr. Soto:

Enclosed are four (4) copies of the final technical report for Symposium Q, "High Temperature Superconductors – Materials Challenges," as required under ONR Grant N00014-98-1-0839.

If you require additional information, please contact me. The Materials Research Society appreciates your continued support.

Sincerely,

Donna J. Gillespie

Symposium Funding Administrator
gillespie@mrs.org

Enclosure

cc: Dr. Siu-Wai Chan, F98Q Symposium Co-Organizer (wo/enclosure)
Defense Technical Information Center (w/enclosure)
Grant Administrator, Regional Office Chicago (wo/enclosure)

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